

Evaluating Risk to Subsistence Food Users

Abstract for ASTSWMO poster session

Overview

Many of Alaska's contaminated sites are located in rural areas where people rely on wild plants and animals as their primary source of food. Most of Alaska's communities are not near a road system prohibiting easy transportation of supplies of commercial foods. Rural villages have limited or no airline service and have only wintertime access via snow machine or ice road.

The gathering and eating of wild foods is an important part of the rural economy and one of the most highly valued parts of a rural lifestyle. The use of traditional foods provides a basis for cultural, spiritual, medicinal, and economic well being among Alaska Natives and indigenous peoples. In addition, traditional foods provide inexpensive and readily available nutrients providing protection from diabetes and cardiovascular disease. Many rural Alaskans depend on wild foods such as salmon, caribou, and seal and prefer them even when commercial foods are available.

Standard assumptions used to assess exposure to contaminants in an urban setting may be grossly inaccurate in an area where people rely heavily on local fish, game, and vegetation. In fact, risk to human health can be significantly underestimated if site-specific information about the extent of reliance on wild food is not used when assessing risk at a site.

The Alaska Department of Environmental Conservation (DEC) wants to ensure that risks to rural Alaskans eating wild foods harvested near contaminated sites are accurately evaluated. DEC has extensive experience in collecting and incorporating data on consumption of fish, game, and vegetation during the risk assessment process.

Unique Process

DEC has developed a process to evaluate potential risk to people who use wild animals and plants in areas affected by contamination. DEC's process has been refined through a series of trials. In 1997, DEC proposed a model which assumed use of wild foods in Alaska fell into five distinct patterns corresponding to geographical regions of the state. DEC developed consumption rates for each region. Comments received from the public emphasized that the results from this approach were too general to make exposure assumptions that could be used to assess risk at a site. It was noted that traditional foods consumed in Alaska vary considerably by geographic region, local preference, and season. The results of this trial showed that estimates on how much wild food people in a village are eating must be made on a local basis.

The Alaska Department of Fish and Game, Division of Subsistence collects local information on harvest, use, and giving and receiving of wild foods through household surveys conducted in approximately 220 rural communities throughout the state. Data from these surveys is compiled in the Community Profile Database (CPDB). Information on harvest and use of a resource for an individual community was used to estimate how much wild food is eaten by a member of that community. These estimates on consumption were used in human health risk assessments.

In 1999, DEC worked with the Division of Subsistence to refine the CPDB to use the harvest and use information to calculate estimates on consumption. Previous studies done by DEC have shown a good correlation between harvest rates and consumption of wild foods in rural communities. The earlier version of the CPDB only showed mean per capita harvest rates, such as 120 grams per day of sockeye salmon harvested per person in Akhiok. Harvest rates assume that a food resource is equally divided among community residents but not all people in a community participate in harvest or use of a resource.

Consumption estimates differ in that they assume wild food is eaten only by people living in households that reported using that resource. The revised CPDB includes estimates of how much of a resource is eaten by the average person in the community consuming that resource. The CPDB also provides consumption estimates for a person that relies more heavily on wild foods. For instance, the revised CPDB shows a high end user in Akhiok consumes 200 grams per day of sockeye salmon. This high end user consumption estimate can then be input into the exposure assessment section of a risk assessment as the ingestion rate for that food. The consumption estimate is generally higher than the harvest rate, providing a more protective estimate of risk of exposure to contaminants.

Although use of the refined CPDB has proven to be a good approach to estimate how much is consumed, these rates are not available for all locations. In addition, information on what parts of the animal are consumed (i.e. liver, brain, muscle) or how food is prepared is not captured in the database but may affect exposure significantly. Soliciting feedback from community members through surveys, interviews, or community meetings to verify the accuracy of the subsistence data is a critical step in DEC's process. Restoration Advisory Boards formed at some of Department of Defense sites, such as Adak, King Salmon, and Northeast Cape, have provided one mechanism to verify use of wild foods in certain communities.

Success/Benefits/Accomplishments

DEC's experience incorporating subsistence data into risk assessments is highlighted in 12 site examples including sites at Adak, King Salmon, Dutch Harbor, Galena, Northeast Cape, and Red Dog. We have found using a combination of local consumption estimates from the CPDB and community input on applicability of these levels is a valuable way to estimate potential risk to people who consume wild foods in contaminated areas. We can then set appropriate cleanup levels and methods which are protective of people participating in subsistence activities. Multiple decision documents have been developed at sites such as King Salmon, Adak, and Alaska Pulp Corporation, based on subsistence risk assessment using the methods discussed above.

Contact for more information

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Appendix: Examples

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Introduction

The Alaska Department of Environmental Conservation's experience incorporating subsistence data into risk assessments is highlighted in the following 10 examples. They elaborate on DEC's process, which uses a combination of local consumption estimates from the Alaska Department of Fish and Game's Community Profile Database and community input on applicability of these levels. We at DEC have found this to be a valuable way to estimate potential risk to people who consume wild foods in contaminated areas. We can then set appropriate cleanup levels and methods which are protective of people participating in subsistence activities.

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ADAK ISLAND



Background: The former Navy Air Facility Adak is located off the Alaskan mainland near the center of the Aleutian chain, approximately 1,200 miles west-southwest of Anchorage, Alaska. The Bering Sea surrounds the island to the north and the Pacific Ocean to the south, making it accessible by only air and water. The Navy manages approximately 79,200 acres of the northern portion of the island, owned by the U.S. Department of the Interior. The southern portion is both owned and managed by the DOI through the U.S. Fish and Wildlife Service. The Aleut Corporation will acquire Adak's facilities under a pending land transfer agreement. Properties are currently under lease. The transfer is contingent on approval by both the Department of Defense Explosives Safety Board and the EPA.

The Aleutian Islands were historically occupied by the Unangas, later called “Aleuts” by the Russians. The once heavily-populated island was abandoned in the early 1800s as the Aleutian Island hunters followed the Russian fur trade eastward and famine set in. They continued, however, to actively hunt and fish around the island over the years until World War II broke out. The military installation was established during World War II to train U.S. troops for defensive action against Japanese forces occupying Attu and Kiska Islands in the Aleutian chain. Adak later became a Naval Air Station, serving during the Cold War as a submarine surveillance center. The station officially closed in March 1997. Since 1985, the Navy has been engaged in cleanup operations under the EPA’s CERCLA program and the State-Adak Environmental Restoration Agreement. The naval site was added to the National Priorities List in 1994. Environmental contaminants discovered at Adak have been associated with historical releases of petroleum products as a result of years of fuel use and handling facility-wide as well as ordnance from military training operations.

Community Profile: 37.3% of the population is Alaska Native or part Native. Adak was deemed a 2nd Class City in April 2001. Subsequently, the Adak City Council was formed and is preparing for the transfer between the Navy and The Aleut Corporation. During 2002 an estimated 149 people were living in the community.

Exposure pathways for subsistence foods: The contaminants of concern in relation to subsistence were polychlorinated biphenyls (PCBs). The potential receptors were residents who may practice subsistence activities at water bodies down gradient of contaminated sites. Receptor scenarios considered for the water bodies included the subsistence fisher and the recreational fisher. The current recreational fisher is described as a resident living on Adak for five years and the future subsistence fisher is described as a resident who spends their entire life on Adak. The definition of “fisher” also includes harvesting shellfish. These scenarios account for the possibility that future land use may be associated with commercial fishing and/or a native community.

Gathering Site Specific Data: Based on consultations with the community, subsistence food studies were designed to include five aquatic biota species: Pacific Cod, Pacific

Halibut, Rock Greenling, Rock Sole, and Blue Mussels. In addition to the subsistence food study, baseline conditions were established at the Bay of Islands as background or reference area samples.

The alternative Record of Decision of 1999 for chemical contamination required an educational program, the posting of advisory signs along shorelines and implementation of a long-term marine monitoring program. Sampling over the next two years confirmed that PCB concentrations were decreasing over time. Rock Greenling, Pacific Cod, and Pacific Halibut, were eliminated from the sampling program as concentrations of PCBs in these species fell below cleanup levels. Blue Mussels, a strong indicator of sediment condition and Rock Sole (more representative of near shore benthic conditions than Pacific Halibut and therefore more exposed to up gradient onshore contaminants) continue to be sampled annually in Kuluk Bay and Sweeper Cove where PCB has been detected in unacceptable concentrations.

Current Status: Initially, seven fish advisory signs were posted at Kuluk Bay and Sweeper Cove, recommending that fishers limit their diets of Rock Sole and Blue Mussels to two 8-ounce meals per week due to low levels of PCBs detected in the tissue. Recreational fishing: when testing showed that recreational fishing no longer poses a health risk, advisory and educational materials regarding these exposure scenarios became no longer necessary.

Subsistence fishing: Approval in June 2003 of a Proposed Plan for a ROD Amendment. Fact sheets replaced the subsistence fish advisory signs. The fact sheets provide a greater level of detail on the presence of PCBs in specific species and discuss potential health risks and benefits associated with fish consumption for the subsistence fisher. In August of 2003, the annual round of the long-term marine monitoring program will commence. This round will be the 5th round of sampling.

ALASKA PULP CORPORATION

Background: The Alaska Pulp Corporation (APC) Silver Bay Mill was located approximately five miles east of Sitka, Alaska. Sitka is located on the west coast of Baranof Island fronting the Pacific Ocean, on Sitka Sound. The city is not connected to a road system but is accessible by regular air, barge and ferry boat service.



APC operated the mill from 1959 until its closure in the fall of 1993. Historical wastewater discharges from the mill were the predominant source of chemicals and organic matter to Silver Bay. Mill effluent was discharged directly to Silver Bay from 1959 to 1971. After state and federal regulations were implemented in 1971, effluent was treated in a treatment plant located on mill property. Contaminants of potential concern evaluated during the 1996 Remedial Investigation included substances associated with organic matter degradation, metals, and organic compounds such as PAHs and dioxins/furans.

Community Profile: Approximately 9,000 people live in the City and Borough of Sitka. The Sitka Tribe of Alaska, consisting of about 3,000 members, is the governing body for Natives in the Sitka area.

Contaminants of concern included dioxins/furans, organic compounds and metals that have accumulated in Silver Bay sediments and along the hillsides adjacent to the mill. Many of these bioaccumulative contaminants could travel through the food chain and impact subsistence species.

Exposure pathways for subsistence foods: Subsistence resources of primary concern during the development of the human health risk assessment included a variety of salmon, flatfish, rockfish, shellfish and marine algae species. The main terrestrial subsistence resource considered was the Sitka black-tailed deer. Determining how Silver Bay is used for subsistence activities, quantifying appropriate subsistence food intake rates, and calculating accurate “site use factors” were the biggest challenges. Subsistence consumption rates are high in Sitka, but Silver Bay is used less than other available subsistence gathering areas. Silver Bay is a designated Customary and Traditional Use Area under State of Alaska regulations.

Gathering Site Specific Data: Public involvement sessions were held at project milestones. A Citizens Advisory Committee was active during the planning phases. The Sitka Tribe of Alaska was represented on the Site Investigation and Remediation Team, a multi-organizational body that helped plan and review technical studies and reports.

Although the Sitka Tribe argued that their members use Silver Bay as a subsistence gathering area up to 20% of the time, no quantifiable data were available to document this assertion. Published information from the Alaska Department of Fish and Game’s Division of Subsistence resulted in site use factors of less than 1% for all resources. The differences were resolved by extrapolating percentages based on the total area used for

subsistence in the Sitka area. A comparison with information from other communities in Southeast was also made to "ground-truth" the extrapolation. DEC contracted a local anthropologist to write a white paper on subsistence use in Sitka. He concluded that the Silver Bay area was not heavily used for subsistence gathering except for deer (13%). All this information was weighed to arrive at the decision.

Current Status: The Record of Decision was signed in April 1999. A stipulation for subsistence-specific aquatic biota sampling during the 10th year of natural recovery was included in the long-term Bay Unit monitoring program. However, the primary purpose of monitoring is to evaluate the recovery of the Silver Bay benthic community, an ecological rather than a human health issue.

CAPE ROMANZOF

Background: Cape Romanzof Long Range Radar Site (LRRS) is located 540 miles west of Anchorage on a small peninsula that extends into the Bering Sea. The 4,900-acre installation, operated by the U.S. Air Force (USAF), is surrounded by the Yukon Delta National Wildlife Refuge. Cape Romanzof is accessible only by boat or plane. The radar station was one of the 12 original Aircraft Control and Warning sites in Alaska's air defense system. Construction was finished in 1952, and operations began in 1953. In 1979, a commercial satellite earth terminal system replaced the White Alice Communications System.



The primary on-site contaminants are petroleum-related compounds released during site operations. Soils are contaminated with diesel and gasoline constituents. The Air Force has been engaged in cleanup operations under the Installation Restoration Program, the Air Force equivalent of EPA's CERCLA program. Much of the contaminated soil has been excavated and is being treated on site. Petroleum compounds have been detected in soils, sediments, and surface waters at Lower Camp. Disposal areas at Upper Camp contain mostly construction debris that was pushed over the south side of the mountain. There are approximately fifteen sites at Cape Romanzof.

Community Profile: The nearest villages to Cape Romanzof are Scammon Bay, Chevak, and Hooper Bay. All of the villages are 2nd Class cities with no organized Borough and are not accessible by road. Chevak has a population of 765 people, 95% being Alaska Native. Tribal entities include the Chevak Traditional Council and Chevak Company Corporation. Hooper Bay has a population of 1,075 people, 95% of which is Alaska Native. Tribal entities include the Sea Lion Corporation and Native Village of Hooper Bay. Scammon Bay has a population of 491 people, 97% being Alaskan Native. Tribal entities include the Askinuk Corporation and Scammon Bay Traditional Council.

Non-military uses of the facilities at Cape Romanzof LRRS include limited hunting and fishing on or near Lower Camp. Regular hunting and fishing occurs at the beach area, and in nearby Kokechik Bay. Area residents camp on USAF property for a few weeks each summer. Subsistence gathering occurs while engaging in the small commercial herring fishery. Fishing for several resident and migrant species occurs in the waters on or adjacent to the beach area. Harvested species include Alaska blackfish, whitefish, Dolly Varden, trout, herring, and several species of salmon.

Exposure pathways for subsistence foods: The contaminated media is soil, sediments, groundwater and surface water. Potential exposure pathways include ingestion, inhalation, and dermal contact with site contaminants, and ingestion of contaminated plants, fish, and animals.

Gathering Site Specific Data: Following consultation with the community, subsistence food studies include herring roe and kelp, plus plants: kelp, Marsh Marigold,

Crowberries, and Labrador Tea; fish: Tomcod and young Dolly Varden; shellfish: blue mussel, Alaska razor clam, and chitons. The potential contaminant transport to subsistence foods include the presence of contaminants in: plants growing at contaminated sites that may be used for human consumption; and fish, and aquatic plant tissue found in surface waters associated with contaminated sites.

To date, no focused ecological studies have been conducted on potential impacts of contaminants to wildlife and fish resources in the area. There are no data for possible contaminant levels in the fish species eaten by the people in the region. This issue was a concern to the community and was identified by a preliminary survey conducted by the U.S. Fish & Wildlife Services in 1991. Native communities surrounding the site have repeatedly voiced concerns about the health of the wildlife and fish surrounding the site that they depend on for subsistence. Site specific information on subsistence foods was gathered by consulting with core group representatives chosen by each community to represent them. Information regarding subsistence foods included: amounts consumed, seasonal availability of subsistence foods, and locations used for subsistence activities. This project is ongoing and will consist of an intensive 2-year study.

Current Status: The Air Force has just begun their work on this study in June 2003 and therefore there are no preliminary results or recommendations expected from this first season until the winter of 2003 or spring 2004.

Of the fifteen sites studied, and following site specific Proposed Plans, there is one final Record of Decision covering three sites with a five-year review of the selected remedial actions is scheduled for 2007. Draft decision documents are expected on seven sites in 2004.

DUTCH HARBOR

Background: Dutch Harbor is a water body adjacent to Amaknak Island near the city of Unalaska, which encompasses Amaknak Island and a portion of Unalaska Island in the Aleutian Chain approximately 800 air miles from Anchorage. Unalaska is a rapidly-growing and culturally-diverse community, primarily focused on fishing and fish processing activities. The name Dutch Harbor is often applied to the portion of the Unalaska on Amaknak Island. Daily commercial air transportation is available.



Blue mussel samples collected in the mid 1990's indicated a higher level of contaminants, primarily polychlorinated biphenyls (PCBs), at Dutch Harbor than at other locations in Alaska. Contaminants have entered the marine environment through spills, runoff, wastewater discharges, groundwater transport, and past disposal practices. In 1999, the Environmental Protection Agency (EPA) conducted an expanded site inspection (ESI) to define the extent of impacts, identify potential source areas and evaluate the site for addition to the National Priorities List. The ESI documented low level PCBs in marine sediments in Dutch Harbor and low level metals, PCBs and other persistent organic pollutants in biota. Upland PCB source areas were identified at the power plant and a former transformer platform, both located immediately adjacent to Dutch Harbor. Potentially responsible parties include the Department of Defense (former owner and operator of the power plant and electrical distribution system), the City of Unalaska (current owner of the power plant) and the Ounalashka Corporation (current owner of the former transformer platform property).

Community Profile: The 2000 census estimated 4,283 people lived in Unalaska; however, the population fluctuates around the commercial fishing seasons. Approximately 10% of the population is Alaska natives and 25% is Asian. Nearly 2,000 transient seafood workers are present between January and April. Local governments include the City of Unalaska and the Qawalangin Tribe of Unalaska. The Ounalashka Corporation manages the lands transferred to the Aleuts. On June 3, 1942, Unalaska was attacked by the Japanese. Almost all of the Aleuts on the Island were interned to Southeast Alaska for the duration of World War II, during which approximately 65,000 military personnel were stationed in Unalaska. After the war, Unalaska was economically depressed until the king crab fisheries boom in the 1960's. The Port of Unalaska is now one of the top commercial seafood ports in the country based on volume and dollar value.

Exposure pathways for subsistence foods: Fish and seafood are extremely important to the area residents both economically and for subsistence use. Uptake into marine organisms occurs and people harvest marine foods. DEC, the Alaska Department of Health and Social Services (DHSS) and EPA worked with the Qawalangin Tribe and the Aleutian Pribilof Island Association (APIA) to obtain information on subsistence activities around Dutch Harbor. Subsistence foods include, but are not limited to,

chitons, limpets, sea anemones, salmon, rock fish, halibut, cod, birds, gull eggs, seals and sea lions.

Some residents have reduced their consumption of traditional foods due to concerns over contaminants. Most native residents avoid collecting foods in Dutch Harbor and rely more on outlying bays. However, transient workers collect foods from the throughout the area and may not be aware of or concerned over potential contaminants.

Gathering Site Specific Data: The ESI sampling plan was developed in consultation with the tribe and APIA. Mussels and sea urchins were collected as good indicators of contamination in localized areas. Flatfish were sampled to assess higher trophic level organisms. A stellar sea lion blubber sample from Unalaska Bay was also analyzed with the understanding that results would not be directly related to contaminants in Dutch Harbor (the Tribe wanted the data to help evaluate the health of subsistence foods on a larger scale). Tissue samples were analyzed for metals, PCBs, semivolatile organic compounds (SVOCs), organochlorine pesticides, dioxins and furans. Separate fish tissue samples consisting of fillets with the skin on and livers were collected. EPA published the ESI report in 2000 documenting low-level contaminants in various environmental and biological samples. Source areas containing higher levels of PCBs in soil were documented at the power plant and beneath a former transformer platform at a nearby warehouse.

A formal risk assessment has not been conducted on the site, however, EPA conducted a preliminary limited risk evaluation using conservative assumptions and calculated ingestion rates based on the ADF&G subsistence database. Their evaluation indicated potential risks above EPA's acceptable levels from: dioxin/furans in fish livers and sea lion blubber; PCBs in flat fish, fish livers and sea lion blubber; arsenic in fish, sea lions, mussels and urchins; and, pesticides in sea lion blubber. The report indicates that further characterization and/or cleanup are warranted.

The Alaska DHSS conducted a public health consultation on contaminant levels in subsistence foods. It concluded that that contaminant levels found in marine organisms are too low to cause adverse health effects in people and that residents should continue to eat their traditional foods. DHSS also reviewed data from the sea lion blubber sample results and concluded that although organochlorine levels were higher in the sea lion, the levels did not warrant restricting subsistence intake. They did recommend further research into persistent organic pollutants in marine mammals.

Current Status: EPA has deferred listing the site on the National Priorities. Overall the status of the Dutch Harbor PCB contamination issue is that DEC is working with the City of Unalaska, the Corps of Engineers and the Ounalashka Corporation on characterization and cleanup at the power plant and former transformer platform. There does not appear to be any unacceptable risks to human health based on consumption of subsistence foods from the area and no remedial actions are planned for the marine areas.

GALENA AIRPORT

Background: The Galena Airport is located in the City of Galena on the Yukon River about 270 miles west of Fairbanks, Alaska. The airport was constructed in 1940 and supported the Alaska-Siberia route for transfer of aircraft to the Soviet Union during World War II. Since 1951, the U.S. Air Force has had joint civilian-military use of the airfield, which became a Forward Operating Base for fighter-interceptors to meet the threat of Soviet bombers during the Cold War until the base was drawn down in 1993. The U.S. Air Force now maintains the area in “Sleeper” Status via a contractor. Galena is accessible by air, and via boat and snow machine on the Yukon River. Through military operations over the years, releases of hazardous chemicals (fuel, solvents, and pesticides) occurred via spills or historical disposal practices.



Community Profile: Galena is not organized in a borough, but has both a City and Tribal (Louden Tribal Council) Government. It is located in traditional Koyukon Athabaskan Indian territory and the population is approximately two-thirds Alaska Native. During 2002 an estimated 713 people were living in the community. The airport offers the only year-round access.

Exposure pathways for subsistence foods: A conceptual model is currently being developed for this site via interviews with the Galena residents and an intensive evaluation of the hydrogeology. The contaminants of concern may include benzene, toluene, ethyl benzene, xylenes, trichloroethene, dichloroethene, vinyl chloride, polynuclear aromatic hydrocarbons, polychlorinated biphenyls (PCBs), pesticides, and metals. The contaminated media includes soil, groundwater, and air. It has not been confirmed yet if the Yukon River is impacted.

The primary subsistence activity of concern is fishing from the Yukon River. Other activities may include berry-gathering, and moose and bird hunting. These activities are currently being identified and clarified. Potential exposure pathways include ingestion, inhalation, and dermal contact with site contaminants, and ingestion of contaminated plants, fish, and animals.

Gathering Site Specific Data: Data collection on subsistence activities is primarily being coordinated through the Loudon Tribal Council. The first activity will be community interviews. Others have not yet been decided.

Current Status: The project is currently in the process of developing a working conceptual site model and completing remedial investigation work. The outstanding issues are many; however, the main questions are the following:

- Is contamination reaching the Yukon River?
- Is contamination reaching the drinking water wells?
- How much risk is posed by the indoor air impacts?
- Is there exposure to contamination via the subsistence pathways?

KING SALMON AIR STATION

Background: King Salmon Air Station (KSAS) is approximately 280 miles southwest of Anchorage, Alaska, and adjacent to the community of King Salmon. The area is not accessible by road. The installation was established in 1941 by the U.S. military as a supply and support base for the Aleutian Island campaign during World War II. During the Cold War, the Air Force used the base as part of a permanent air defense system and placed in caretaker status in a condition to permit rapid reactivation in 1994. Since 1985, the Air Force has been engaged in cleanup operations under the Installation Restoration Program, the Air Force equivalent of EPA's CERCLA program.



The contaminants of concern were DRO, GRO, PAHs, PCBs, and lead at two drum disposal sites, and DRO, GRO, and PAHs at a fire training site, two bulk petroleum storage and handling sites, and a former landfill. The contaminants were mainly associated with historical releases of petroleum products from years of fuel use and handling facility wide, as well as past operations and disposal practices.

Community Profile: King Salmon is part of the Bristol Bay Borough. The borough functions as the official governing body for Naknek, South Naknek, and King Salmon. During 2002 an estimated 392 people were living in the community, and the population of Bristol Bay Borough (comprised of Naknek, South Naknek, and King Salmon) was 1,258. The population is 30% Alaska Native, which includes a mixture of Aleuts, Indians and Eskimos. Tribal entities include the Naknek / South Naknek Village Native Council and the King Salmon Village Council.

Exposure pathways for subsistence foods: The potential receptors were on-site or nearby residents who may practice subsistence activities at wetlands or streams associated with contaminated sites. The contaminated media was soil and surface water. Potential exposure pathways include ingestion, inhalation, and dermal contact with site contaminants, and ingestion of contaminated plants, fish, and animals.

Gathering Site Specific Data: Following consultation with the community, subsistence food studies included blueberries, lowbush and bog cranberries, morel mushrooms, and other plant tissues (such as marsh fivefinger leaves traditionally used for tea, berry leaves, and moss), and aquatic biota (such as juvenile salmon, rainbow trout, Alaska blackfish, sticklebacks, dolly varden, sculpin, arctic grayling, and aquatic plant tissue). The potential contaminant transport to subsistence foods include the presence of contaminants in: berries and mushrooms growing at contaminated sites that may be used for human consumption; and fish and aquatic plant tissue found in surface waters associated with contaminated sites. In addition to the subsistence food study, the baseline conditions of the wetlands were determined by establishing transects within contaminated zones and up and down gradient of the contaminated zones in each wetland. Contamination levels were determined along each transect and a baseline ecological evaluation was performed.

This issue was a concern to the community and was identified as a data gap by an evaluation conducted by the Agency for the Toxic Substances and Disease Registry (ATSDR) in 1995. The King Salmon Restoration Advisory Board (RAB) was officially formed in 1995, to serve as a forum for discussion and exchange of information between federal/state agencies and the community regarding the cleanup program at KSAS. The RAB provides opportunity for stakeholders to review cleanup progress, provide input, and participate in dialogue with decision-makers. The RAB is comprised of representatives from the local community, tribes, and the installation, and attended by federal, state, and local government representatives. Site specific information was gathered by consulting with the RAB regarding subsistence foods, amounts consumed, and locations used for subsistence activities. RAB members familiar with collection of morel mushrooms and aquatic biota provided identification and locations to the field collection team. This project consisted of an intensive 2-year study with four sampling rounds, followed by a focused aquatic biota sampling at three sites where additional sampling and evaluation was deemed necessary.

Current Status: The focused aquatic biota project is complete, and results indicate that certain contaminants of potential concern (COPCs) detected at some of the sites are also present in fish samples collected at or near those sites. These include some pesticides (i.e. DDT, chlordane, hexachlorobenzene, etc.); benzene, toluene, ethylbenzene, and xylenes (BTEX); and PCBs. The concentrations of these chemicals in fish are below screening values with a few exceptions. Low levels of COPCs were detected in sediment and surface water samples, including background samples. Chemicals detected in sediment and surface water that were also detected in fish include: BTEX; DDT; chlordane and its constituents; hexachlorobenzene; and dieldrin. Comparison of the concentrations of chemicals in sediment and water to screening criteria indicates a small portion of samples exceed the criteria. Generally, the frequency of detections and concentrations at locations immediately down gradient of suspected source areas are higher than that observed at distant down gradient locations, which supports the concept of natural attenuation of chemicals migrating from source areas.

Project recommendations and future projects include additional aquatic biota sampling at 5-year intervals to determine trends of exposure to chemical contaminants, and as a baseline for monitoring the remediation at KSAS, and continued monitoring of surface water and sediment to provide evidence of long-term trends.

Of the six sites studied, and following the site specific Proposed Plans, there are three final Records of Decision with 5-year reviews scheduled in 2004 and 2005, one Interim Record of Decision, and two scheduled Record of Decisions for late 2003.

KETCHIKAN PULP COMPANY

Background: The Ketchikan Pulp Company (KPC)

Ward Cove Mill was located approximately five miles north of Ketchikan, Alaska. Ketchikan is located on the southwestern coast of Revillagigedo

Island near the southern boundary of Alaska and 679 miles north of Seattle. The city is not connected to a road system but is accessible by regular air, barge and ferry boat service.



KPC operated the mill from 1954 until its closure in 1997. Historical wastewater discharges from the mill were the predominant source of chemicals and organic matter to Ward Cove sediments. Mill effluent was discharged directly to Ward Cove from 1954 to 1971. After state and federal regulations were implemented in 1971, effluent was treated in an uplands treatment plant located on mill property. Contaminants of potential concern evaluated during the 1997 Remedial Investigation included substances associated with organic matter degradation, metals, and organic compounds such as PAHs and dioxins/furans.

Community Profile: Approximately 13,700 people live in the Ketchikan Gateway Borough. Communities within the borough include Ketchikan and Saxman. Tongass and Cape Fox Tlingits have lived in the area historically. Nineteen percent of the population is Alaska Native or part Native. The Ketchikan Indian Corporation is the governing body for Natives in the Ketchikan area.

Contaminants of concern included dioxins/furans, organic compounds and metals that have accumulated in Ward Cove sediments and the may be available to food chain receptors.

Exposure pathways for subsistence foods: The primary subsistence foods of concern were several species of salmon and shellfish. Determining how Ward Cove is used for subsistence activities and quantifying appropriate rates of subsistence food intake were the biggest challenges. While seafood consumption rates may be relatively high for some communities within the Ketchikan area, Ward Cove is only one of many fishing areas available to residents. Fishing takes places mainly at the outlet to Ward Creek. Shellfish collection is uncertain but probably limited because the majority of Ward Cove is represented by sub-tidal habitat. Ward Cove is not a designated Customary and Traditional Use Area under State of Alaska regulations.

Gathering Site Specific Data: A questionnaire was sent to every mailing address in Ketchikan asking individuals to identify concerns regarding potential contaminant releases. A limited number of door-to-door interviews were conducted. Numerous public meetings were held. In the end, intake rates based on average data from the Alaska Department of Fish and Game's subsistence harvest database for the community of

Saxman were determined to be protective because that data are representative of a more sensitive sub-population.

Current Status: The Marine Operable Unit Record of Decision, signed March 29, 2000, includes no stipulations for subsistence-specific aquatic biota sampling. The long-term monitoring program is designed to evaluate the recovery of the Ward Cove benthic community, an ecological rather than a human health issue.

NORTHEAST CAPE, ST. LAWRENCE ISLAND



Background: Northeast Cape is a Formerly Used Defense Site located on Saint Lawrence Island in the Bering Sea. The island is about 500 miles west northwest of Anchorage and 140 miles southwest of Nome. The site is approximately 45-miles southeast of Savoonga, the nearest village. There are no roads or established trails to the site, which is accessible only by boat, plane, snow mobiles or 4-wheeler. There are no permanent residents, though there is summer time use (fish camp) by residents of the Island. The facility is made up of two separate sites - the Air Force Aircraft Control and Early Warning Station and a White Alice Communications Station. The facility was built in 1957 and 1958 to aid in military surveillance during the cold war and abandoned in 1972. The environmental cleanup is under the jurisdiction of the Corps of Engineers (COE).

Large areas at Northeast Cape are contaminated by petroleum in the soil and groundwater. An estimated 180,000 gallon diesel fuel spill in 1969 impacted a nearby river drainage. Some sediment in this drainage basin is also impacted with polychlorinated biphenyls (PCBs). Fish (Dolly Varden) sampled from the drainage have been found to contain PCBs at concentrations slightly above the ingestion levels recommended by the Environmental Protection Agency.

Community Profile: The site has no permanent residents. The island is owned by two native corporations, the Sivuqaq Corporation (village of Gambell) and the Savoonga Corporation. Each village has about 600 residents. Each village has a tribal council (IRA), city government structure, and corporation structure.

Exposure pathways for subsistence foods: Various species of greens, berries and root plants are occasionally harvested from the area, although survey respondents indicated that the majority of plants harvested from the Cape are taken a distance from the impacted site areas. Reindeer meat and fish are also consumed.

Gathering Site Specific Data: The most problematic area of gathering subsistence data is to get community participation. Simply dropping off survey forms to the community was not practical. A local representative along with a COE contractor needs to sit down with the community members who utilize the site and go through the survey questions together. A translator is generally needed to help with the species names, descriptions and spelling of native species.

Survey and interview information were used to determine the types and amounts of plants and animal foods taken from Northeast Cape. Combining the survey information with the USEPA consumption rates (1997) yields a plant intake for adults (four meals per month) of 7 grams per day, 2 grams per day for a child. Intake assumptions for fish were three meals per week during the summer (mid June through mid September) and one

meal per week of dried fish the remainder of the year. These rates yield 9 grams per day of fish for adults and 3 grams per day for children. Reindeer were determined to be so migratory that the percentage of exposure time on the site would produce an insignificant contaminant contribution to the animal.

The principle contaminant of concern in subsistence foods at Northeast Cape is PCBs. Petroleum compounds do increase cumulative risk, but mostly in the event of using impacted groundwater as drinking water. Low level Polyaromatic Hydrocarbons (PAHs) were detected in a small number of fish and reindeer tissue samples, but at concentrations well below screening levels.

The contribution of PCBs into the food web from the military site or from global transport is not determined. Background samples from a creek several miles from the Cape showed PCB concentrations in fish tissue similar to those found in the Northeast Cape drainage. Determining the contribution would involve detailed congener analysis and is generally beyond the scope of a typical environmental cleanup. PCBs found in migratory species such as marine mammals and salmonoids are especially problematic because of their migratory nature. PCBs found in plants are more indicative of local site contribution, however atmospheric transport must be considered.

The community has expressed concern over cancer rates and a possible link to the former military sites. The concern includes direct chemical exposure from people who worked at the former facilities, and also from multiple year exposure to contaminated subsistence foods. The Saint Lawrence Island RAB has been a useful vehicle for getting information to interested community members and creates a convenient reoccurring forum to distribute information.

Current Status: Several steps are occurring simultaneously at Northeast Cape. The site is nearing the end of a three phase Remedial Investigation. A summary will soon go to DEC to review for adequate characterization of the various sites. The draft risk assessment is being updated to a draft final. Also ongoing is a two year, \$10 million building demolition/debris removal project that will remove all the buildings and exposed debris from the site with a \$6 million option to do more work at the former White Alice Site. Limited containerized hazardous toxic waste work is included. The next phase is to produce a Feasibility Study to determine how to best remediate the remaining contamination.

RED DOG MINE

Red Dog Mine is located approximately 90 miles northwest of Kotzebue, Alaska, and 55 miles inland from the Chukchi Sea. The closest communities to Red Dog Mine are Kivalina and Noatak, in Southwest Alaska. Red Dog Mine is primarily accessed by plane both in winter and summer months. Red Dog was first discovered in 1953 and production of the mine began in 1989 by Teck Cominco. Red Dog Mine is currently an operating zinc and lead mine.



The contaminants of concern at the site are primarily lead, zinc and cadmium but also include DRO, GRO, PAHs, and BTEX. Contaminants are mainly associated with fugitive dust from the transportation of the ore concentrate between the mine and the port along 52 miles of the De Long Mountain Transportation System.

Kivalina is the closest community to Red Dog Mine. Kivalina is part of the Northwest Arctic Borough. The community lies in the transitional climate zone which is characterized by long, cold winters and cool summers. The average low temperature during January is -15°F; the average high during July is 57°F.

During 2002 an estimated 383 people were living in the community. A federally recognized tribe is located in the community – the Native Village of Kivalina. The population of Kivalina is 96.6% Alaska Native and the community is a traditional Inupiat Eskimo village. Subsistence activities, including whaling, provide most food sources.

The potential receptors were on-site or nearby residents who may practice subsistence activities especially near the port along wetlands or streams associated with the site. Contaminated media include soil and sediment. Potential exposure pathways include ingestion, inhalation, and dermal contact with site contaminants, and ingestion of contaminated plants, fish, and animals.

In June 2001 the National Park Service released a study, *Heavy Metals in Mosses and Soils on Six Transects Along the Red Dog Mine Haul Road Alaska*. The report generated a great deal of concern regarding the safety of consuming subsistence foods along the road. In the summer of 2001, DEC sampled plants and berries near the port to assess the concentrations of heavy metals in these subsistence foods.

In October 2001 the Alaska Department of Health and Social Service issued the report, *Public Health Evaluation of Exposure to Kivalina and Noatak Residents to Heavy Metals from Red Dog Mine*. The report focused on the potential for human exposure to heavy metals from Red Dog Mine and the Port Facility and to assess the potential for harm to heavy metals to residents of communities located in the vicinity of the mine. The report investigated exposure to drinking water, soil, sediment, fish, caribou, and salmonberries. The report concluded that the concentrations of heavy metals did not pose a public health hazard to residents of Kivalina or Noatak.

Additional information on the use of subsistence foods was gathered through multiple open meetings with the communities of Noatak and Kivalina. In May and June, 2002 DEC staff held meetings with the Northwest Arctic Borough, Maniliq Health Corporation staff, NANA Subsistence Committee members and the villages of Kivalina and Noatak to gather information on what foods were used, when they were collected and how they were prepared. This information was used to develop a conceptual site model to be used in a risk assessment at the site.

Currently a risk assessment at the site is being conducted. In June, 2003 a work plan was submitted to the Department for review. Revisions to the work plan are still underway. Sampling and analysis of the site is being conducted during the 2003 summer to address data gaps for the risk assessment.

UMIAT AIR STATION AND UMIAT TEST WELLS



Background: Umiat Air Station and test wells comprise 8,000 acres located about 150 miles southeast of Barrow and 70 miles southwest of Nuiqsut on the north shore of the Colville River. Access is limited mostly to air travel, with occasional river traffic in the summer and snow machine traffic in the winter. Umiat consists of a runway complex, main gravel pad, a landfill for disposal of drums and other debris in the 1970's, and 11 Navy oil test wells located throughout the 8,000 acre area. Umiat does not have a resident community, but for many years the O.J. Smith family operated a small lodge there. Umiat is used as a base camp for hunting, research, fish and wildlife surveys, and oil exploration. Residents of the village of Nuiqsut are the most directly affected community.

The U.S. Army Corps of Engineers is the responsible party, conducting investigation and cleanup under the Formerly Used Defense Sites (FUDS) program. The contaminants of concern in the soil and sediments at the sites include: petroleum (GRO, DRO and RRO), polychlorinated biphenyls (PCBs), antimony, barium, lead, arsenic, and DDT. The COCs found in the groundwater above the permafrost include: GRO, DRO, benzene, polyaromatic hydrocarbons (PAH), PCBs, chromium, lead, and thallium.

Community Profile: Nuiqsut, population 443, is the nearest community and located in the North Slope Borough. The majority of the population consists of Inupiat Eskimos practicing a traditional subsistence lifestyle. The Colville Delta has traditionally been a gathering and trading place for the Inupiat and has always offered good hunting and fishing. The old village of Nuiqsut (Itqilippaa) was abandoned in the late 1940s and resettled in 1973 by 27 families from Barrow. The Native Village of Nuiqsut is a federally-recognized tribe. The North Slope Borough provides all utilities in Nuiqsut.

Exposure pathways for subsistence foods: Subsistence foods evaluated included: berries, caribou/moose, ptarmigan, and fish species – grayling, whitefish, and burbot. Subsistence exposure was evaluated for caribou/moose, ptarmigan, berries, and fish, as well as for direct exposure through soil ingestion or inhalation for people conducting subsistence activities on the sites. Caribou/moose, ptarmigan, and berries were evaluated at all of the sites. Fish were only evaluated for the Landfill site, where PCBs were detected in the sediments of a down-gradient seasonal slough. Exposure pathways for caribou/moose and ptarmigan were soil ingestion and surface water ingestion by animals, then subsistence ingestion of the animals by people. Exposure pathway for berries was uptake from the soil by the plants, and subsistence consumption of berries by people.

Gathering Site Specific Data: Ingestion rates were obtained for Nuiqsut using harvest data as a surrogate for ingestion, assuming that the harvest rate equals the ingestion rate. Harvest rates were obtained from the State of Alaska Department of Fish and Game Community Profile Database. The conservative assumption was made that all of the subsistence resources would be collected at Umiat.

Evaluation of fish was much more complicated. Initial ingestion rates were based on fishing done by the O.J. Smith family, as community interviews indicated that subsistence fishing was not done immediately around Umiat. The Smith family indicated that they never fished from the slough, so their maximum fish consumption from the Colville River was used to represent potential uptake of fish from the slough. Modeling showed a potential risk.

The most complex issue was evaluating risks associated with ingestion of fish. The risk assessment showed a potential risk, so tissue samples were collected from grayling in the slough. Much more extensive sampling was conducted in the slough sediments. After consultation with the community, a second round of fish sampling evaluated white fish and burbot in the slough and up-river and down-river of the slough. White fish were selected because they are harvested in large numbers. Burbot were harvested to represent a fish high on the food chain, and because burbot livers are a delicacy, especially for elders in the winter time. A third round of fish sampling occurred to evaluate burbot (whole body and liver) at the slough and at six reaches of the Colville River between Umiat and Nuiqsut to look for site-related effects extending beyond the slough.

The Alaska Department of Health and Social Services (DHSS) assisted in interpretation of the data and prepared a draft health consult later finalized by Agency for the Toxic Substances and Disease Registry (ATSDR) and presented to the community of Nuiqsut. A Restoration Advisory Board was then formed in Nuiqsut, and members provided input. An evaluation of all data to date was performed by the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM). Their report was finalized in July 2003.

Current Status: Risk Assessments and associated Health Consultation reports are complete for Umiat. No risks were found for subsistence ingestion of birds or mammals, as represented by caribou/moose and ptarmigan. Risks were found for ingestion of berries, primarily from uptake of naturally-occurring arsenic. It is highly unlikely, however, that enough berries are present at the well sites for an individual to harvest sufficient berries to pose a risk, and RAB members seem to accept this, as they don't harvest berries in that area anyway.

Evaluation of risks associated with ingestion of fish is complete, but the CHPPM final report still needs to be presented to the RAB. All three levels of reports – from Alaska Department of Health and Social Services, ATSDR, and CHPPM, have reached similar conclusions. The CHPPM report basically concludes that there are local effects on the burbot in the slough, but not on the rest of the river. It further concludes that the slough does not comprise enough of a fishery to support enough fish to result in a risk to human health, even if a person fished exclusively from the slough. Additional assistance in interpreting this data may be requested from other organizations before RAB members will accept the results, as the whole issue is very sensitive to the community.

A Proposed Plan has been completed for the Main Gravel Pad, Airstrip Complex, and ten of the eleven test wells. Public review of the Proposed Plan ends August 7, 2003. Decision Documents are in the process of being written, with the hopes of finalizing them by the end of August, 2003.

CAPE LISBURNE LRRS

Background: Cape Lisburne Long Range Radar Station

(LRRS) is an active U. S. Air Force facility located in northwestern Alaska between the Arctic Ocean and

Chukchi Sea. The radar station is within the Alaska Maritime National Wildlife Refuge, located 570 miles northwest of Fairbanks and 300 miles southwest of Barrow. The facilities were constructed in 1952 as part of the Cold War and are still active today as part of the LRRS system. During the past operations at the station there have been releases of petroleum, polychlorinated biphenyls (PCBs), and halogenated/non-halogenated solvents.



Community Profile: Point Hope is the closest community to Cape Lisburne located 25 miles to the south-southwest. Point Hope is located on a large gravel spit that forms the western-most extension of the northwest Alaska coast. According to a 2002 census there were 709 residents in the community. Point Hope is part of the North Slope Borough and is a 2nd Class City. The city is one of the oldest continuously occupied Inupiat Eskimo areas in Alaska. Residents are dependent on seals, bowhead whales, beluga whales, caribou, polar bears, birds, fish, and berries for their subsistence lifestyle. Access to the site is by regularly scheduled aircraft or boat/barge during the summer months.

Exposure pathways for subsistence foods: Exposure pathways identified as inhalation/ingestion of soil/dust for humans; ingestion/inhalation of soil/dust and ingestion of sediment and surface water for mammals; ingestion of sediment, soil, and surface water for birds; and direct contact with surface water for aquatic organisms. Potential receptors identified as installation workers, visitors, contractor personnel, governmental personnel, Inupiat subsistence hunters, and fishermen from the village of Point Hope, moose, caribou, grizzly bear, polar bear, parka ground squirrels, lemmings, birds, and aquatic organisms. The site is in prime caribou calving and grazing area.

Gathering Site Specific Data: Of highest concern to the community was the PCB contamination at an old military landfill / waste disposal area, at the White Alice Site and at transformer buildings. The risk assessment done for this site was an older one done without considering risk to subsistence uses. To compensate for this, the State and Air Force looked at ecological risks, considered food sources and receptors, and used risk management in deciding upon cleanup levels and remedies. Environmental justice issues were involved in that when the station was put in place, eight families were displaced and moved to Point Hope. Cleanup decisions included the possibility that people would move back there. In general, cleanup needed to take into account that present and future use of the area includes subsistence food gathering.

The community at first was very distrustful of either government entity. Trust was built up through repeated work with the Restoration Advisory Board and the Native Village of Point Hope (tribe). Site tours were conducted by the Air Force. The final decisions concerning PCB contamination ensure that there are no pathways from remaining PCBs to users of subsistence resources.

Current Status: The cleanup remedy chosen for the PCBs at the landfill and other PCB areas is to excavate soil down to 1 ppm throughout the soil profile and haul it away for off-site treatment/disposal. Excavated areas will be backfilled with clean soil and graded and revegetated to prevent future erosion. A beach erosion study was conducted specifically to evaluate the potential for erosion of the landfill area because of concerns about PCBs entering the marine environment and impacting marine subsistence resources. The study found that the bluff is over stable bedrock, giving assurance that trace residual contamination at the bottom of the excavations will not will not end up eventually entering the ocean through erosion. The residents of Point Hope are very satisfied with the remedy. In addition, the relationships built through this process have sparked other projects benefiting the community. For example, the location of a gravesite was identified and marked on site documents. Since Cape Lisburne has a continuing active military mission, this will allow protection and preservation of this site from future activities. The village of Point Hope now has a project to develop a facility to store and preserve artifacts found at the historic village site.

The final Record of Decision has been signed by the State, and signature is pending from the Air Force. Cleanup is expected to be completed during the summer of 2004. A Clean Sweep program demolished lower upper camp buildings in summer 2001, lower camp buildings summer 2002.

NAVAL ARCTIC RESEARCH LABORATORY



Background: The Naval Arctic Research Laboratory (NARL) was established 5.5 miles northeast from Barrow by the Office of Naval Research in 1947. Barrow is located on the Chukchi Sea 725 miles from Anchorage and accessible only by aircraft. The University of Alaska Fairbanks operated the lab from 1954 to 1980 in conjunction with numerous contractors. NARL provided facilities and logistical support for high Arctic research in oceanography, biology, and ice research until its closure in 1980. Ukpeagvik Iñupiat Corporation (UIC) then approached the Office of Naval Research and was granted title to the major portions of the property. The facility is now called UIC-NARL. The Navy retains ownership of an old airstrip and associated hangar, and of a large area inland of the developed part of NARL. These areas will be transferred to UIC when cleanup is complete.

During the facility's operation there have been several documented releases to the environment. Gasoline and jet fuel spills totaling about 366,000 gallons dating from the 1970s were documented at the Airstrip site. Approximately 140,000 gallons was recovered at the time of the spills, and another estimated 100,000 gallons was recovered during interim cleanup actions and from a product recovery system during 1996- 1999. Other contaminants of concern are halogenated (PCE) and non-halogenated solvents associated with a dry cleaning facility, fuel spills and polychlorinated biphenyls (PCBs) at a former powerhouse site, and fuel leaks and spills at a former bulk fuel tank farm.. Imikpuk Lake borders the Airstrip site and provides drinking water supplies for homes, commercial and industrial tenants, and a community college located at the facility. The North Salt Lagoon, which is important for local subsistence fishing, borders the Bulk Fuel Tank Farm. The responsible party for the cleanup is the U.S. Navy.

Community Profile: The closest community to the site is the town of Barrow, the northernmost community in Alaska. As of 2002 Barrow contained 4,434 people. The city is part of the North Slope Borough and is a 1st Class City. Most of the residents in Barrow are Inupiat Eskimos. Water is derived from a dam on Isatkoak Lagoon and is stored in a tank. Most residents have piped water, but nearly one-half use honeybuckets for sewage disposal. The member-owned Barrow Utilities & Electric Cooperative provides electricity, water and sewage treatment services, and piped natural gas for home heating. The North Slope Borough provides all other utilities.

Exposure pathways for subsistence foods: Many of the residents participate in subsistence activities harvesting: bowhead, gray, killer and beluga whales, seal, polar bear, walrus, duck, caribou and arctic grayling and whitefish from the coast or nearby rivers and lakes. North Salt Lagoon presented the major threat to subsistence resources where the risk assessment showed a potential health hazard to subsistence users from potential exposure to diesel range aliphatics through consumption of the lake's fish.

Gathering Site Specific Data: Community input was sought from members of the Restoration Advisory Board, UIC, the Native Village of Barrow, and the Inupiat

Community of the Arctic Slope, a tribal consortium. In addition, one man who fishes in the lake was interviewed extensively and hired to help collect fish for sampling. He was of great value in determining which species to consider. As a result of these consultations, fish of representative species were sampled, and the determination was that there was no detectable uptake of these petroleum compounds in the fish.

Current Status: The bulk fuel tank farm posed the major threat to subsistence resources from migration of petroleum contamination to fish in the North Salt Lagoon. Risk-based cleanup levels were set to protect subsistence resources and to prevent off-site migration. Cleanup includes excavation and thermal treatment of heavily contaminated soil near the shore, and landfarming of adjacent less contaminated soil. Cleanup levels and remedial actions at the other sites were selected to protect for all present and future uses, including elimination of exposure pathways for subsistence use of resources. At the airstrip site, the remedy included construction of an impermeable barrier between the site and Imikpuk Lake to protect from migration of free product and contaminated groundwater. At present, no further recoverable product can be found at the site. The airstrip, powerhouse, and bulk fuel tank farm sites will have remedial actions completed by the end of the 2003 season and will be in long-term monitoring status. DEC and the Navy signed the final Record of Decision for these NARL sites in late winter 2003.